Phase 0/I
Flight Safety Data Package
for Experiment Equipment and Operations
of the
Human Research Facility

February 1999
(original release)

National Aeronautics and Space Administration

Lyndon B Johnson Space Center
Houston, Texas 77058

LS-71066-1

PREFACE

This Human Research Facility (HRF) Experiment Phase 0/I Flight Safety Data Package includes safety information for experiment operations and experiment unique hardware associated with the HRF program. Facility hardware used to support these experiments has previously been presented per document number LS-71027. The hazards identified in these Phase I Hazard Reports include descriptions, causes, controls and safety verifications. All verification items remain open at this time.

This package contains chapter 12 of the HRF Experiment Equipment and Operations Flight Safety Data Package. This experiment, and associated hardware, is scheduled for launch and initial flight operations on ISS Increment 10.

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12.0 A COMPREHENSIVE CHARACTERIZATION OF MICROORGANISMS AND ALLERGENS IN SPACECRAFT ENVIRONMENT (SWAB[⊗]) (99-E049)

All previous microbial analysis of spacecraft utilized culture-based methodology, omitting greater than 90% of all microorganisms including pathogens such as *Legionella* and *Cryptosporidium*. Culture bacteria and fungi have been the only allergens studied; the more potent allergens, such as dust mites, have never been analyzed in spacecraft environments. No attempt has been made to monitor microbial toxins. This experiment will utilize modern molecular biology, advanced microscopy, and immunochemical techniques to study air, surface, and water samples from spacecraft. These samples will be analyzed for bacteria and fungi (total composition and specific pathogens), pathogenic protozoa, specific allergens, and microbial toxins. This study will provide a comprehensive analysis of the International Space Station (ISS) by:

- Monitoring the ISS modules prior to launch to develop a baseline of contamination
- Monitoring launch vehicles to evaluate sources of new contamination
- Direct sampling of the ISS

Surface samples will be collected using a damp swab and liquid vial currently designed as the contingency method for the NASA Surface Sample Kit, approved for inflight use. Upon return to Earth, the swab and buffer are sonicated to facilitate microbial detachment into the liquid. Potable water samples will be collected directly into 1 liter Teflon bags currently approved for inflight use. ISS water sampling sites will include the Russian pasteurization system (SRV-K) that regenerates water for potable use as well as the SVO-ZV dispensing ports. If available, free-floating condensate, which accumulates during extended missions, will be collected using a contingency syringe.

[⊗] SWAB (Surface Water and Air Biocharacterization) is the Common name for the Experiment

Air samples will be collected via a COTS Air Sampling Device (ASD) manufactured by Sartorius Co. The ASD will draw air through a gelatin membrane filter, which will capture any airborne microbes. The membrane filters will be returned to the ground for analysis.

Once the samples are returned to Earth, they will be analyzed by a combination of polymerase chain reaction (PCR), quantitative PCR (QPCR), denaturing gradient gel electrophoresis (DGGE), and 16S ribosomal analysis to enumerate and identify all bacterial species in every sample. In addition, the samples will be analyzed for endotoxin levels using the Limulus amebocyte lysate (LAL) endotoxin assay, and direct imaging for allergens will be performed using the environmental scanning electron microscope (ESEM) and immunogold labeling. Initial analyses of all bacterial protocols will be compared to results using the standard culture-based methodologies of the Microbiology Laboratory at JSC.

12.1 HARDWARE DESIGN

The hardware utilized for the SWAB Experiment includes the battery-operated Air Sampling Device (ASD) and gelatin membrane filter units. The surface and water sampling protocols will utilize CHeCS hardware. For surface sampling, a cotton swab inside a vial moistened with a buffer solution will be used. For water sampling, Adapter Probes with Luer Lock fittings will be attached to 1-L Potable Water storage bags. Two different adapters will be used to collect samples from the different water sampling sites.

Specifically, the hardware includes:

Air Sampling:

Air Sampling Device (ASD)

ASD Battery Packs

ASD Filter unit

Water Sampling:

Water Sampler Assembly, Adapter, Potable, Sterile

Adapter Probe Assembly, SVO-ZV Port

HRF SWAB Water Bag

Contingency Syringe (condensate collection)

Surface Sampling:

HRF SWAB Tube

12.1.1 Air Sampling Device

The air-sampling device is a slightly modified AirPort MD8 built by Sartorius, an environmental and biotechnology company based in Germany.

Figure 12-1: AirPort MD8

The AirPort is battery operated, utilizing a primary battery pack (non rechargeable) composed of five (5) 3.4 V 7.0 Ah Lithium Bromide Complex cells (Li-BCX) configured in a series pack. The battery cells are tested and certified cells from USA/FCE that have been approved for use by the EP5 JSC battery group. The cells will be purchased for use by the experiment team and configured into the series pack using 2 parallel shunt diodes per cell for overdischarge of each cell as well as a resettable polyswitch (fuse) for short circuit protection. See figure 12-2 for the battery cell setup and the entire ASD block diagram.

A second battery pack configuration is also under consideration. This battery pack is rechargeable and consists of 14 Panasonic HHR380A NiMH cells. Each cell has a nominal voltage of 1.2V with a capacity of

3800 mAh. The complete battery pack generates 16.8 volts with a capacity of 3800 mAh. The batteries are rechargeable but will not be recharged in-flight. This battery schematic is shown in Figure 12-4.

To acquire the air samples, the AirPort uses Gelatin Membrane filter units, which are specialized 80mm gelatin filter discs configured with a plastic holder. The gelatin is composed of a water gelatin matrix with industry standard processed porcine collagen. The Filter Units are attached to the front of the device when sampling and replaced for each sampling period.

Approximately 1.0 m^3 of air will be sampled per module. The airflow rate and sample volume is adjustable via a keypad on the top of the unit. The airflow is generated with a rotating anemometer, which rotates up to 20,000 rpm, but is completely enclosed within ABS plastic and also within the housing of the unit.

To support the SWAB Experiment and develop the ASD into flight hardware, the COTS ASD will be slightly modified.

The modifications to this unit include:

1) Addition of a Nomex cover for flammability reasons

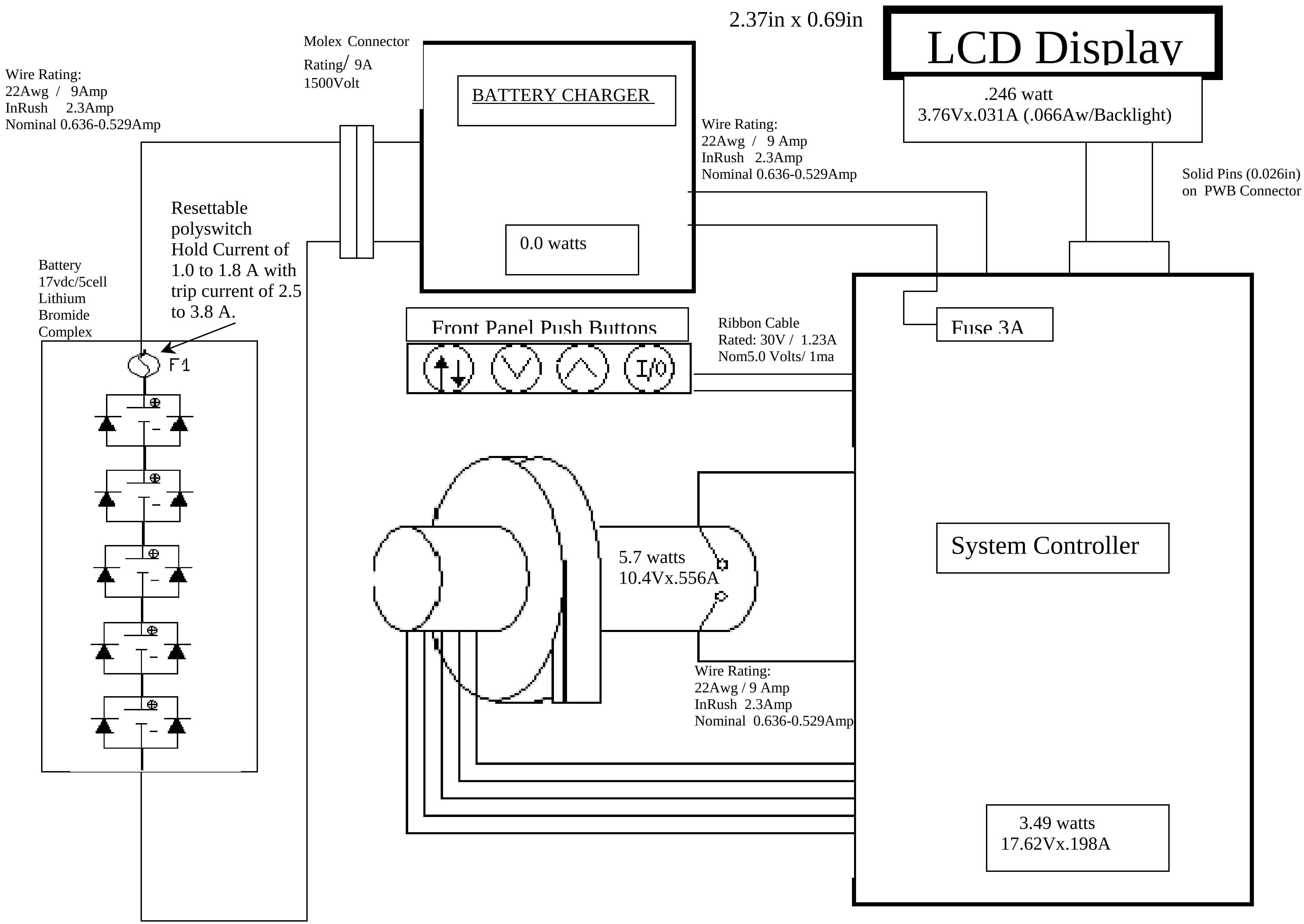
2) Replacement of the current battery compartment screws with a thumbscrew to allow battery replacement without the need for tools

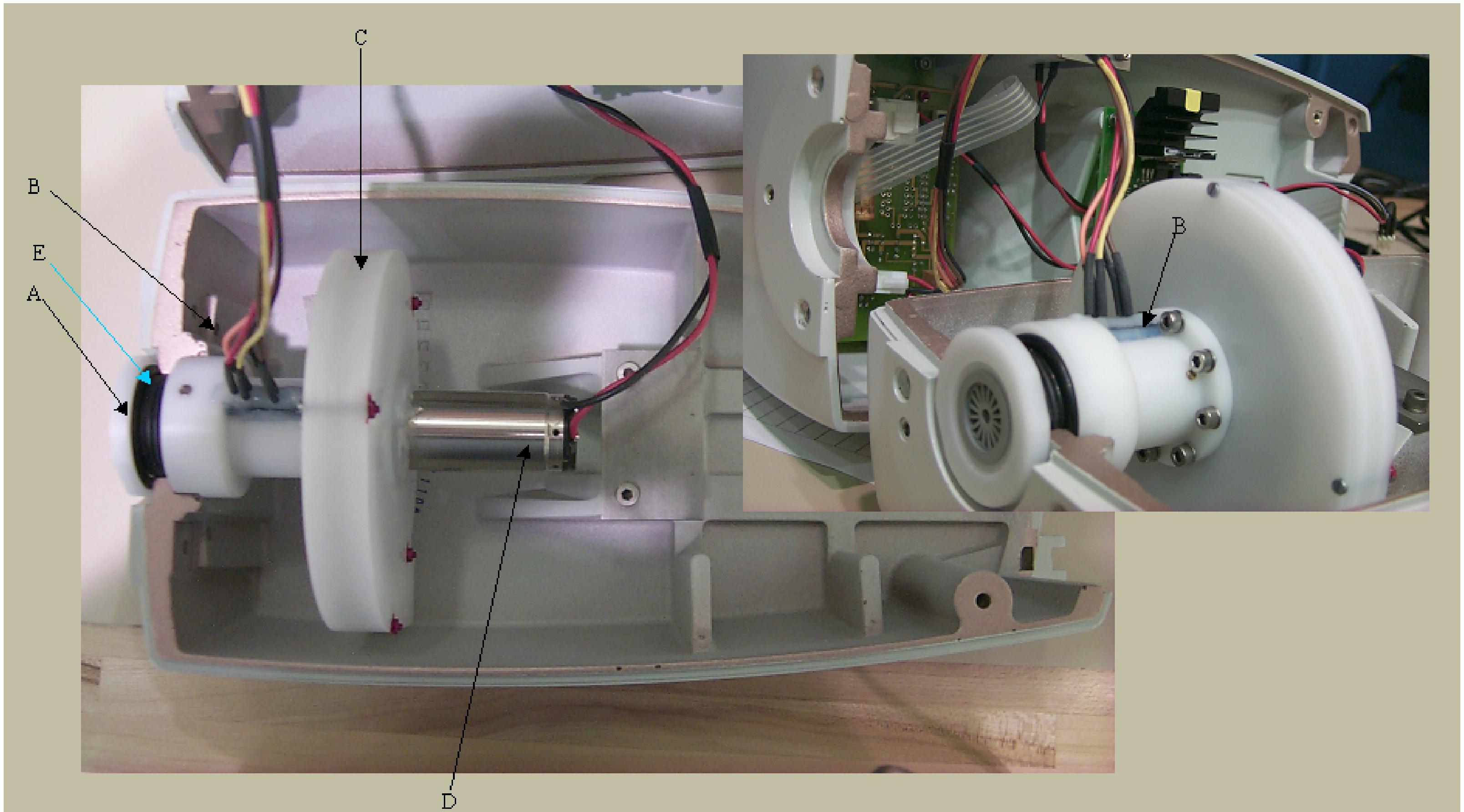
3) Conformal coating of circuit boards

4) Upgrade wiring from non-mil spec wires to Mil Spec proper rated wires with Teflon coating

5) Remove internal connectors with direct soldering to boards to remove potential problem areas as a result of vibration.

Figure 12-2: Wire Diagram for the Air Sampler Device and Battery Pack





A	Air is drawn through this Inlet port (Made of ABS, Acrylonitrile - Butadiene – Styrene)
B	Opto-electronical Sensor, which continually measures the airflow rate that is digitally controlled. 6 impulses per rotation = frequency
C	Integrated propeller anemometer (hydrometric vane, stainless steel) housed in ABS. RPMs = 12000 – 20000
D	DC Motor which drives the integrated propeller anemometer
E	O rings (Silicone)

Figure 12-3: Internal components of the AirPort MD8

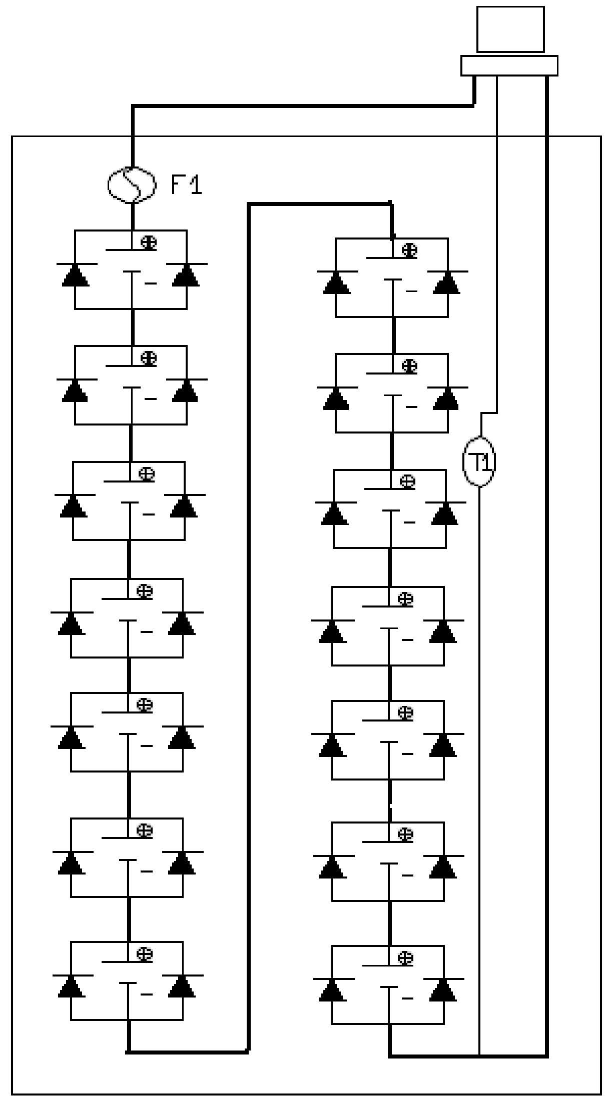


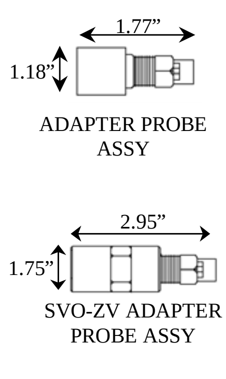
Figure 12-4 Alternate battery pack schematic

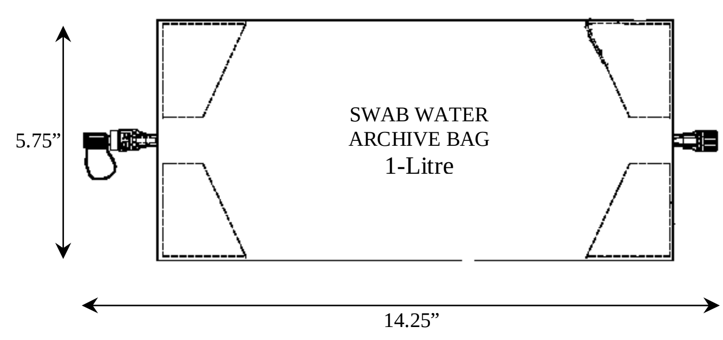
12.1.2 Water Sampling Hardware

The water sampling hardware has been previously approved for use in the CheCS program. It includes the 1-liter Teflon sample bag, the 2 adapter probe assemblies and the contingency syringe (not shown). The adapter probes connect to the water source and the water bags connect to the luer fitting on the adapters. Each session will use a separate adapter probe and water bag. The assembled water bags will be placed into special waterproof Vectran bag during and after the water sampling for possible leak containment. An additional change to the Water Sampling Equipment will be the removal of the CHeCS label and addition of the experiment specific SWAB label. A fixative agent will be added to the water bag prior to flight. The proposed fixative is:

Water archive bags will contain, in powder form, the following substances:
(final concentrations are based on the assumption that 1 Liter of water is added)

10 grams of Sodium Dodecyl Sulfate (1% final concentration)
1.21 grams of Trizma Base (10mM final concentration)
0.37 grams of EDTA (1mM final concentration)

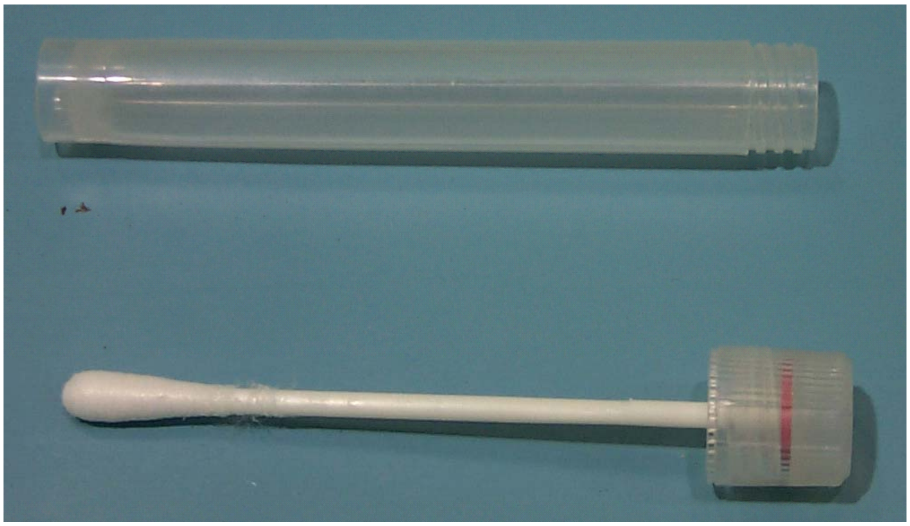




In the event that free-floating condensate is found, a contingency syringe will be used to collect the condensate and transfer it to a collection bag.

12.1.3 Surface Sampling Hardware

The surface sampling hardware required for this experiment has been previously approved for use in the CheCS program. It includes the surface sampling tubes as shown below. The swab is a Dacron swab with a screw



SWAB Surface Sampling Tube

cap. A special SWAB label will be placed around the swab tube. Inside the swab tube will be approximately 1 ml of a fixative agent to moisten the swab and provide a buffering agent to prolong the validity of the specimen. The proposed solution is:

1% Sodium Dodecyl Sulfate Solution
10mM Tris-HCl (Trizma Base adjusted to pH 8.0)
1mM EDTA pH 8.0 Solution (Ethylenediaminetetraacetic acid adjusted to pH 8.0)

12.2 OPERATIONS

12.2.1 Launch/Ascent and Transport to Station

The hardware will be launched soft-stowed in kit form. The SWAB Kits will include all hardware necessary to complete the Surface, Water and Air sampling protocols. No shuttle services are required during transport to ISS. It is anticipated that the SWAB ASD will remain on orbit for the length of the experiment. Additional SWAB Sample Kits will be launched as needed and the SWAB Transfer Kit will be returned with samples on each shuttle flight throughout the experiment. The experiment is expected to be performed during 2 consecutive increments.

12.2.2 On Orbit Scenario

During the experiment, three different sample types (air, water and surface) will be collected. The number of sessions is based on launches to the ISS. Within approximately 48 hours of docking, the experiment is requesting to acquire the samples. Presently, four sessions of Water, Surface and Air Sampling are planned per increment based on previous and future launch schedules.

For Air Sampling, the HRF ASD, as well as a Filter Unit Assembly, will be unstowed. The filter unit assembly is attached to the front end of the ASD at the adapter attachment point. Once configured the unit can be carried to the predetermined locations and turned on. Since the device is hand held, it can be used in any habitable module as well as any launch vehicle. Once the ASD is “ON” the crewmember operating the device will set the sampling parameters including sample volume and sample flow rate. Once set, the unit is started and sampling will begin. Air is drawn through the membrane filter via the internal impeller wheel. Each air sampling session will take approximately 20 minutes to sample 1000 litres or 1.0 m^3 of air. After the sampling session has completed, the user can verify the amount of air sampled. The unit will shut itself off after a short period of inactivity. Once off, the filter unit is removed from the filter adapter and placed into a zip lock bag and stowed in the SWAB Transfer Kit, which will eventually return to ground. This process is repeated to obtain a 1000 liter sample in each module. After all samples are collected, the SWAB ASD is returned to the SWAB ASD kit and stowed.

Surface samples will be taken at a variety of locations, including several air supply surfaces, food locker surfaces, and water dispenser surfaces.

Essentially, a surface sampling vial from the SWAB Stowage Kit will be removed and the cotton swab from the vial will be used to “swab” a 25 cm^2 area. Once completed, the cotton swab is returned to the sample vial and marked with the date and location of the sample. It will then be stowed in the SWAB Transfer Kit. The sample vial contains a fixative/buffer solution that moisturizes the swab so surface samples will adhere to the swab, and preserves the acquired sample for extended mission time. Two surface samples from each ISS module will be collected.

Water sampling will take place from 4 water sources: Potable water from the SRV-K Hot and Cold ports, the SVO-ZV potable dispenser ports and Free-floating condensate (if available). When collecting potable water samples, the Potable Water Sampler adapter is connected to a 1-liter collection bag and the potable water source. Each source requires a separate adapter that will be stowed inside the SWAB Sample Kit. An unused adapter probe will be used for each session.

In the event that free-floating condensate is found, a contingency syringe will be used to collect the condensate and transfer it to a collection bag. After use, these bags are stowed within an additional Ziploc bag and then in the SWAB Transfer Kit.

12.2.3 Rapid Safing

No special procedures are required in the event of an emergency egress.

12.2.4 Fire Protection

Fire prevention is handled in the design process. The air sampler is made with approved materials and with proper wire sizing and circuit protection. Elimination of fire sources through conformal coating and electronic parts derating was implemented. Proper grounding is also implemented.

Fire detection would be handled by the area smoke detector if the ASD is left unattended.

The Portable Fire Extinguisher (PFE) with the wide area/diffuser nozzle would be used for fire suppression.

12.2.5 Maintenance and calibration

No special calibration or maintenance processes are needed for the ASD. No maintenance will be performed on this hardware.

12.2.6 Aging and disposal

If the hardware fails to operate properly, the entire unit will be replaced.

12.3 INTERFACE REQUIREMENTS

No critical services are required from the orbiter or ISS for this hardware item.

This hardware has no data interfaces.

There are no electrical interfaces to the vehicle. The air sampler is battery operated.

12.4 SAFETY ASSESSMENT

Payload safety critical subsystems are normally subdivided into pressure systems, radiation, mechanical, structural, electrical, human factors, and materials categories for consideration. The following categories are applicable to the SWAB ASD hardware and are documented on the Form 1230 in Appendix 12A.   A unique hazard report has been generated for battery leakage/rupture for each proposed configuration and can be found in Appendix 12B.   There are no hazard controls requiring crew procedures or crew training.

12.4.1 Human Factors

Construction of the SWAB hardware will meet the requirements specified in SSP 57000, section 3.12.9.2, for sharp edges, corners, or protrusions. No potential pinch points have been identified.

The SWAB air sampler will meet touch temperature requirements of letter MA2-95-048, “Thermal Limits for Intravehicular Activity (IVA) Touch Temperature”.

12.4.2 Materials

All materials selected for the manufacture and construction of flight hardware, both metallic and non-metallic, will meet the requirements specified in applicable requirements documentation (MSFC-HDBK-527/JSC 09604, “Materials Selection List for Space Hardware Systems”; SSP 30233, “Space Station Requirements for Materials and Processes”; NSTS 1700.7B, “Safety Policy and Requirements for Payloads Using the Space Transportation System”; and NSTS 1700.7 ISS Addendum, “Safety Policy and Requirements for Payloads Using the International Space Station”). JSC/EM2 will review and approve all materials for the SWAB hardware and supply the material certification prior to flight.

Toxicity assessments of the buffer/fixative solutions are in work.

The LCD for the control panel is protected with a plastic covering. The LCD uses LED backlighting. No mercury or high voltages are used.

The COTS unit contains one glass fuse, this will be taped and potted with RTV.

12.4.3 Electrical

Circuit protection devices and wire sizes will be selected in accordance with TM102179, " Selection of Wires and Circuit Protection Devices for NSTS Orbiter Vehicle Payload Electrical Circuits" as interpreted by TA-92-038.

There are no internal voltages greater than 32V.

The SWAB air sampler will be in compliance with SSP 30237, "Space Station Electromagnetic Emission and Susceptibility Requirements". EMI compatibility testing will be performed.

12.4.4 Batteries

The AirPort will utilize a battery pack composed of five (5) 3.4 V 7.0 Ah Lithium Bromide Complex cells (Li-BCX) configured in a series pack. The battery cells are tested and certified cells from USA/FCE that have been approved for use by the EP5 JSC battery group. The cells will be purchased for use by the experiment team and configured into the series pack using 2 parallel shunt diodes per cell for overdischarge of each cell as well as a resettable polyswitch (fuse) for short circuit protection. See figure 12-2 for the battery cell setup and the entire ASD block diagram.
An alternate battery pack design is being studied. This battery pack is rechargeable and consists of 14 Panasonic HHR380A NiMH cells. Each cell has a nominal voltage of 1.2V with a capacity of 3800 mAh. The complete battery pack generates 16.8 volts with a capacity of 3800 mAh. The batteries are rechargeable but will not be recharged in-flight. The schematic for this configuration is shown in figure 12-4.

The batteries will follow the guidelines of JSC 20793, "Manned Space Vehicle Battery Safety Handbook," and will be approved for their intended use by the JSC power systems branch.

12.4.5 Rapid Safing

The SWAB hardware will meet the rapid safing requirements of Letter MA2-96-190 and will not impede emergency IVA egress into other pressurized volumes.

12.4.6 Structures

The sampling unit contains a rotating anemometer to create airflow through the unit. This anemometer rotates at speed up to 20,000 rpm and is 3.3" diameter. The anemometer is lightweight (<0.5 lbs) and is double contained within an ABS plastic housing as well as the housing of the overall unit. See figure 12-3. A containment analysis will be performed

12.4.7 Safety Re-verifications

No periodic re-verifications are required to ensure safe operation for the life of this hardware item.

12.4.8 Action Items/Non-compliances/Hardware Anomalies

There are no open action items or agreements on this hardware. No non-compliances have been identified with this hardware. No safety-related anomalies have occurred with this hardware item.

Experiment Unique Acronyms

ASD	Air Sampling Device
CheCS	Crew Health Care System
COTS	Commercial Off The Shelf
SWAB	Surface, Water and Air Biocharacterization
SRV-K	System for Regenerating Water from Condensate
SVO-ZV	Water Supply System Using the Water Supply (water supply equipment)

Appendix 12A:
Standard Hazard Report for the
SWAB Experiment

FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT		A. NUMBER	B. PHASE	C. DATE
		STD- SWAB	**Phase 0/I**	July 2003

D. PAYLOAD, DTO, DSO or RME *(Include Part Number(s), if applicable)*	**HAZARD TITLE**	**E. VEHICLE**
HRF - Surface Water and Air Biocharacterization (SWAB) experiment See attached for P/N	STANDARD HAZARDS	Shuttle/Station

F. DESCRIPTION OF HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:**
1. Structural Failure *(payloads must comply with the listed requirements for all phases of flight)* *Note: Locker and Soft Stowage items only.*	a) Designed to meet the standard modular locker stowage requirements of NSTS 21000-IDD-MDK or equivalent IDD ______ , or b) Stowed in SPACEHAB per MDC91W5023.	☒ ☐	Reference SSP 50321, International Subrack Interface Standard (ISIS) Drawer Specification, limits for weight and c.g. of ISIS drawer with SSCCD approval. OPEN
2. Structural Failure of Sealed Containers	Sealed containers must meet the criteria of NASA-STD-5003, Para. 4.2.2.4.2.3a, contain a substance which is not a catastrophic hazard if released, be made of conventional metals, and have a maximum delta pressure of 1.5 atm.	☐	N/A, no sealed containers
3. Structural Failure of Vented Containers	For intentionally vented containers, vents are sized to maintain a 1.4 factor of safety for Shuttle or a 1.5 factor of safety for Station with respect to pressure loads. Meets all of the applicable pressure rates defined for one or more of the following. i. Shuttle payload bay – ICD 2-19001, Para. 10.6.1 ii. Station environment – SSP 52005, paragraph 4.1.12 or equivalent payload specific ICD ______. iii. Station PFE discharge – SSP 57000, Para. 3.1.1.4K, or equivalent payload specific ICD ______ .	 ☐ ☐ ☐	N/A, no intentionally vented containers.

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HRF - Surface Water and Air Biocharacterization (SWAB) experiment See attached for P/N		STANDARD HAZARDS		Shuttle/Station

F. DESCRIPTION OF HAZARD:	**G. HAZARD CONTROLS:** *(complies with)*	**H. APP.**	**I. VERIFICATION METHOD, REFERENCE AND STATUS:**
4. Sharp Edges, Corners, and/or Protrusions.	Meets the **intent** of one or more of the following:		Sharp edge inspection of as-built hardware. OPEN
	a) NASA-STD-3000 / SSP 50005	☐	
	b) SLP 2104	☐	
	c) NSTS 07700 Vol. XIV App. 7 (EVA hardware)	☐	
	d) NSTS 07700 Vol. XIV App. 9 (IVA hardware) / SSP 57000	☒	
5. Shatterable Material Release	a) All materials are contained.	☒	The LCD is protected by a plastic covering Glass fuse will be taped and potted with RTV QA inspection of plastic covering and systems board. OPEN
	b) Optical glass (i.e. lenses, filters, etc.) components of crew cabin experiment hardware that are non-stressed (no delta pressure) and have passed both a vibration test at flight levels and a post-test visual inspection.	☐	
	c) Payload bay hardware shatterable material components that weigh less than 0.25 lb and are non-stressed (no delta pressure) or non-structural.	☐	
6. Flammable Materials	a) A-rated materials selected from MAPTIS, or	☒	Review/approval of material list and flammability assessments by JSC/ES4 Materials Branch. To be closed by Materials Memo. OPEN
	b) Flammability assessment per NSTS 22648	☐	
7. Materials Offgassing	a) Offgassing tests of assembled article per NHB 8060.1 and/or NASA-STD-6001	☒	Review/approval of offgas testing by JSC/ES4 Materials Branch. To be closed by Materials Memo. OPEN
8. Nonionizing Radiation 8.1 Non-transmitters	a) Pass ICD-2-19001, 10.7.3.2.2 / SSP 30238 EMI compatibility testing, or	☒	Review of test results for successful completion of EMI compatibility testing. OPEN
	b) NSTS/USA approved analysis ICD Section 20, or	☐	
	c) ISS/EMEP approved TIA	☐	

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F. DESCRIPTION OF HAZARD:	G. HAZARD CONTROLS: *(complies with)*	H. APP.	I. VERIFICATION METHOD, REFERENCE AND STATUS:
8.2 Lasers	a) Beams are totally contained at the maximum possible power and there is no crew access, or b) Meet ANSI Z136.1-1993 for class 1, 2, or 3a Lasers (as measured at the source).	☐ ☐	N/A
9. Battery Failure *(use of this form is limited to small commercial batteries as listed below)* 9.1 Alkaline-MnO_2, Carbon- Zn, or Zn-Air in sizes D or smaller having 6 or fewer cells either all in parallel or all in series (series/parallel combinations require a unique hazard report), no potential charging source, and cells are in a vented compartment. 9.2 Li-CFx, Li-Iodine, Li-MnO_2, Ni-Cd, Ni-MH, or Ag-Zn which have a capacity of 200 mAh or less, and no more than 3 cells per common circuit.	Pass acceptance tests which include open circuit & loaded voltage measurements, visual examination, and leakage check under vacuum (e.g. 6 hours at 0.1 psia). *Note: Above acceptance testing for button cells in Section 9.2 which are soldered to a circuit board in commercial equipment (not applicable to those button cells in a spring-loaded clip) is limited to a functional check of the equipment utilizing the subject battery.*	☐	See unique Hazard Report for use of a battery pack. *Note: Application and schematic reviewed and approved by JSC/EP5.*
10. Touch Temperature	a) Within IVA touch temperature range of –18 Degrees C. (0 Degrees F.) and 49 Degrees C. (120 Degrees F.) and satisfies the intentional contact constraints of letter MA2-95-048 (if applicable). b) Meets EVA touch temperature criteria of NSTS 07700 Vol. XIV App. 7.	☒ ☐	Test/analysis to ensure surfaces do not exceed 49°C, including anemometer failure condition. OPEN

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<tr><td colspan="2">FLIGHT PAYLOAD STANDARDIZED HAZARD CONTROL REPORT</td><td colspan="2">A. NUMBER
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STANDARD HAZARDS</td><td>E. VEHICLE
Shuttle/Station</td></tr>
<tr><td>F. DESCRIPTION OF HAZARD:</td><td>G. HAZARD CONTROLS: (complies with)</td><td>H. APP.</td><td colspan="3">I. VERIFICATION METHOD, REFERENCE AND STATUS:</td></tr>
<tr><td>11. Electrical Power Distribution</td><td>a) Shuttle-powered payloads – Meets all circuit protection requirements of Letter TA-92-038.

b) Station-powered payloads – Meets station interface circuit protection requirements of SSP 57000 and payload circuit protection requirements of Letter TA-92-038.</td><td>☐

☐</td><td colspan="3">N/A, hardware is battery powered.</td></tr>
<tr><td>12. Ignition of Flammable Atmospheres in Payload Bay</td><td>All ignition sources in the Payload bay, for launch and landing, are controlled as required in Letter NS2/81-MO82, and MLI grounded per ICD 2-19001.</td><td>☐</td><td colspan="3">N/A</td></tr>
<tr><td>13. Rotating Equipment</td><td>Rotating equipment meets criteria of NASA-STD-5003 for obvious containment.</td><td>☒</td><td colspan="3">The rotating anemometer is 3.3" in diameter and rotates at 20,000 rpm. The anemometer is lightweight (<0.5 lbs) and is double contained with an ABS plastic housing as well as the housing of the overall unit. The anemometer is contained based on engineering judgement. A containment analysis will be performed. OPEN</td></tr>
<tr><td>14. Mating/demating powered connectors</td><td>a) Meets the low power criteria of letter MA2-99-170 or,

b) Meets the paragraph 1 criteria of letter MA2-99-170 (e.g., IVA and open circuit voltage no greater than 32 volts).</td><td>☐

☐</td><td colspan="3">N/A, no mate/demate required.</td></tr>
<tr><td>15. Contingency Return and Rapid Safing</td><td>Shuttle Environment:
a) If middeck payload – can be stowed within 50 min. (see paragraph 3 of letter MA2-96-190).

b) If transfer item – can establish a safe for return configuration within 3 min. (see paragraph 5 of letter MA2-96-190).

Station Environment:
c) Payload design does not impede emergency IVA egress to the remaining adjacent pressurized volumes.</td><td>☐

☐

☒</td><td colspan="3">Review of design to show hardware will not impede emergency egress. OPEN</td></tr>
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<tr><td>16. Release of Mercury from bulbs into crew habitable environment.</td><td>a) Mercury vapor bulbs contain less than 30 mg of Mercury per bulb, and

b) No more than one bulb could break due to a single failure.</td><td>☐</td><td colspan="3">N/A</td></tr>
<tr><td>APPROVAL</td><td colspan="2">PAYLOAD ORGANIZATION</td><td colspan="3">SSP/ISS</td></tr>
<tr><td>PHASE I</td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>PHASE II</td><td colspan="2"></td><td colspan="3"></td></tr>
<tr><td>PHASE III</td><td colspan="2"></td><td colspan="3"></td></tr>
</table>

Hardware List

SEG46119448-301	HRF Air Sampling Device (ASD)
SEG46119449-301	ASD NiMH Battery Pack
SEG46119450-301	ASD Li-BCX Battery Pack
SEG46119451-301	ASD Filter unit
SEG46119455-301	HRF SWAB Water Collection Bag
TBD	Vectran Bag
SEM46110793-306	Water Sampler Assembly, Adapter, Potable, Sterile (SRV-K)
SEM46110793-305	Adapter Probe Assembly, SVO-ZV Adapter
TBD	Contingency Syringe
SEG46119457-301	HRF SWAB Tube
TBD	SWAB Sample Kit
TBD	SWAB Transfer Kit
TBD	Folding scissors
D35100	BZK Wipes

Appendix 12B:
Unique Hazard Reports for the
SWAB Experiment

PAYLOAD HAZARD REPORT

PAYLOAD HAZARD REPORT		**NO:** SWAB-1
PAYLOAD: **HRF SWAB Air Sampling Device**		**PHASE: 0/I**
SUBSYSTEM: Electrical	**HAZARD GROUP:** INJURY/ILLNESS	**DATE: July 2003**

HAZARD TITLE: Battery Leakage or Rupture

APPLICABLE SAFETY REQUIREMENTS:
NSTS 1700.7B 201.3, 209.1, 213.2
ISS Addendum 201.3, 209.1, 213.2

☒ **CATASTROPHIC**
☐ **CRITICAL**

DESCRIPTION OF HAZARD:
The rupture of a NiMH cell within the battery pack and escape of electrolytes or build-up of gases can lead to fire, explosion, corrosion, contamination and potential injury to the crew. The battery pack is made up of 14 3800mAh Panasonic HHR380A NiMH cells. Batteries are rechargeable but will not be recharged in-flight.

HAZARD CAUSES:
1. Short circuit (internal/external)
2. Over-discharging of cells
3. Build up of internal cell pressure.
See continuation sheet

HAZARD CONTROLS:
1.1 Internal short circuit controls included internal battery cell fusing (built within the battery cell itself), polyswitch for the assembled battery pack short circuit protection. External short circuit controls include keyed battery connector; shrink tubing wrapping around cells covering any exposed surfaces.

2.1 Over-discharge will be prevented via the battery pack polyswitch, board mounted 2 A fuse as well as utilizing matched cells.

3.1 To prevent built up cell pressure, all cells are vented and the assembled battery pack is not sealed.

See continuation sheet

SAFETY VERIFICATION METHODS:
1.1.1 JSC/EP5 review/approval of battery circuit design.
1.1.2 Certification of as-built hardware to approved design.
2.1.1 JSC/EP5 review/approval of battery circuit design.
2.1.2 Certification of as-built hardware to approved design.
2.1.3 Verification of cell matching.
3.1.1 JSC/EP5 review/approval of battery circuit design.
3.1.2 Certification of as-built hardware to approved design.

STATUS OF VERIFICATION:
1.1.1Open
1.1.2 Open
2.1.1 Open
2.1.2 Open
2.1.3 Open
3.1.1 Open
3.1.2 Open

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

PAYLOAD HAZARD REPORT CONTINUATION SHEET	NO: SWAB-1
PAYLOAD: HRF – SWAB ASD	PHASE: 0/I

HAZARD CAUSES (continued):

4. Over-temperature
5. Accumulation and ignition of hazardous gas mixture.
6. Inadequate containment of electrolyte.
7. Charging of primary cells.

HAZARD CONTROLS (continued):

4.1 Over temperature hazard is controlled using the battery polyswitch (fuse), surface mounted thermistor on the battery pack for battery charging scenarios as well as the board mounted fuse. The over temperature hazard would only exist in a short circuit situation and not during normal operations.

5.1 To prevent accumulation and ignition of hazardous gasses, the battery pack is not sealed.

6.1 Pigmat wicking material will be included in the design.

7.1 There are no other power sources present.

SAFETY VERIFICATION METHODS (continued):

4.1.1 JSC/EP5 review/approval of battery circuit design.
4.1.2 Certification of as-built hardware to approved design.
5.1.1 JSC/EP5 review/approval of battery circuit design.
5.1.2 Certification of as-built hardware to approved design.
6.1.1 JSC/EP5 review/approval of battery circuit design.
6.1.2 Certification of as-built hardware to approved design.
7.1.1 Review of design to show no other power sources present.

STATUS OF VERIFICATION:

4.1.1 Open
4.1.2 Open
5.1.1 Open
5.1.2 Open
6.1.1 Open
6.1.2 Open
7.1.1 Open

PAYLOAD HAZARD REPORT		NO: SWAB-2
PAYLOAD: **HRF SWAB Air Sampling Device**		**PHASE: 0/I**
SUBSYSTEM: Electrical	**HAZARD GROUP:** INJURY/ILLNESS	**DATE: July 2003**
HAZARD TITLE: Battery Leakage or Rupture		
APPLICABLE SAFETY REQUIREMENTS: NSTS 1700.7B 201.3, 209.1, 213.2 ISS Addendum 201.3, 209.1, 213.2		X **CATASTROPHIC** ☐ **CRITICAL**

DESCRIPTION OF HAZARD:

The rupture of a Li-BCX cell within the battery pack and escape of electrolytes can lead to fire, explosion, corrosion, contamination and potential injury to the crew. The battery pack is made up of 5 3.4V, 7Ah Lithium Bromine Chloride Complex cells configured in a series pack.

HAZARD CAUSES:

1. Short circuit (internal/external)
2. Charging of primary cells
3. Over-discharging of cells

See continuation sheet

HAZARD CONTROLS:

1.1 Internal short circuit controls included internal battery cell fusing (built within the battery cell itself), polyswitch for the assembled battery pack short circuit protection. External short circuit controls include keyed battery connector; shrink tubing wrapping around cells covering any exposed surfaces.

2.1 To control the charging of the cells the external power input connector for charging will be disabled (removed) preventing the possibility of charging. No other power source is present.

3.1 Over-discharge will be prevented via the 2 parallel shunt diodes per cell, battery pack polyswitch and board mounted 2A fuse.

3.2Battery pack will be built using voltage-matched cells.

See continuation sheet

SAFETY VERIFICATION METHODS:

1.1.1 JSC/EP5 review/approval of battery circuit design.
1.1.2 Certification of as-built hardware to approved design.
2.1.1 Review of design to show no other power source is present and power input connector is removed.
3.1.1 JSC/EP5 review/approval of battery circuit design.
3.1.2 Certification of as-built hardware to approved design.
3.2.1Verification of battery cell matching.

See continuation sheet

STATUS OF VERIFICATION:

1.1.1Open
1.1.2 Open
2.1.1 Open
3.1.1 Open
3.1.2 Open
3.2.1 Open

See continuation sheet

APPROVAL	PAYLOAD ORGANIZATION	STS
PHASE I		
PHASE II		
PHASE III		

PAYLOAD HAZARD REPORT CONTINUATION SHEET	NO: SWAB-2
PAYLOAD: HRF – SWAB ASD	PHASE: 0/I

HAZARD CAUSES (continued):
4. Build up of internal cell pressure.
5. Over-temperature (Discharge Only)
6. Inadequate containment of electrolyte

HAZARD CONTROLS (continued):
4.1 To prevent built up cell pressure, all cells are vented and the assembled battery pack is not sealed.

5.1 Over temperature hazard is controlled using the battery polyswitch (fuse) as well as the board mounted fuse. The over temperature hazard would only exist in a short circuit situation and not during normal operations. In addition, the battery pack cannot be charged preventing heating from the charging of the cells.

6.1 Pigmat wicking material will be used in the design.

SAFETY VERIFICATION METHODS (continued):
4.1.1 JSC/EP5 review/approval of battery circuit design.
4.1.2 Certification of as-built hardware to approved design.
5.1.1 JSC/EP5 review/approval of battery circuit design.
5.1.2 Certification of as-built hardware to approved design.
6.1.1 JSC/EP5 review/approval of battery circuit design.
6.1.2 Certification of as-built hardware to approved design.

STATUS OF VERIFICATION:
4.1.1 Open
4.1.2 Open
5.1.1 Open
5.1.2 Open
6.1.1 Open
6.1.2 Open